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LABOUR UTILISATION IN INDIAN AGRICULTURE

A Critical Appraisal of the Literature on Some Aspects of the Problem

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Introduction

Indian agriculture supports the largest share of the working population of the economy. A substantial part of the workers engaged in this sector suffer from chronic underemployment, in the sense that per worker disposable labour time per year is not fully utilised. Simultaneously, it has been observed that labour input per unit of land is the lowest in Indian agriculture compared to some East Asian countries; and this is associated with low level of agricultural output per unit area (Ishikawa, 1978). An interdistrict comparison of Indian data suggests that there is a positive association between output per unit of land and labour use per unit of land (Vaidyanathan, 1978).

These facts immediately raise certain questions:

1. Why, despite underemployment, is there such a low utilisation of labour in Indian agriculture?

2. Following the positive association between output and labour input per acre a question is posed: could the labour time, hitherto unutilised, be productively utilised to bring up the level of agricultural output per unit area? This leads to further question as to what determines the level of output per unit area and the labour input per unit area. Are there common determinants of the two, such that raising output on land will imply raising labour input on land also?

In the light of the above questions we shall review the selected literature on labour utilisation in agriculture. However, the body of literature can be divided broadly into two groups. One group studies the causes of low utilisation of labour per unit area and the ways and means to improve the labour use in agriculture. The main

interest of this group, therefore, is to explore the basic determinants which explain the causes of a particular level of labour utilisation. Another group of studies confines only to the area of technical change. Its particular components, and their influence on the labour input per unit of land. The latter is concerned mainly with the technological breakthrough in new seed-water-fertiliser combination and associated mechanisation leading to a rapid increase in the output per unit of land. The second group poses the following question: Does the yield increasing technological change always absorb labour? Or, are there components distinquishable as labour absorbing and labour displacing?

Methodological consideration

Studies concerned with the determinants of labour utilisation appeared under the heading of Labour Absorption in Agriculture. They are empirical in content which attempt to identify the factors underlying the observed differences in the labour input per unit area, either across farms, or districts or countries. The observed differences may result from the interplay of technological, economic, demographic and institutional factors,[1] or from any one of them alone. The explanatory variables, however, need to be specified, *a priori*, in terms of these factors.

A set of studies under review considers only technological and economic factors responsible for the observed differences in labour use (Vaidyanathan 1978, Vaidyanathan and Jose 1978, Naidu 1977). Various institutional practices and the demographic factors, along with technological and economic factors can also affect the level of labour input per unit area (Ishikawa 1978, Bardhan 1978). Bharadwaj (1974) mainly focuses on the inter - linkages of markets, economic opportunities outside agriculture, size of holding etc., as factors affecting the labour use decision of farm and agricultural labour households.

Above mentioned studies mainly use the correlation and regression techniques often on the cross-section data. As far as Indian cases are concerned the data of the Farm Management Studies (FMS) are most frequently used.

Studies that examine the relative impacts of various technological inputs alone will be covered under the heading of 'Technology and Labour Use'. Since various technological inputs have their influences on labour use both in a crop season and in extending the cropping prospects in other seasons, impact of their uses will be studied in terms of labour use in overall agricultural production.

The studies dealing with technological change and labour utilisation often examine the influence of quantitative or qualitative changes in specific input use on the labour use and yield. But the observed labour use or yield may be influenced by the change in other technological inputs the impact of which is not being examined. In order to ascertain the impact of the specified inputs under examination, the possible influence of the inputs not being examined needs to be removed.

Studies in this area mainly depend on field surveys; only a few use the FMS data. Most of them are cross section analyses, hence the impact analyses are based on the differences in relevant data between the adopters and nonadopters of the specified inputs. In one case (Chopra 1974) we shall come across the study of intertemporal comparison of labour use among users of a particular input.

In the cross section comparison of data between adopters and nonadopters simple percentage differences in the relevant variables can be quite revealing. In case regression equations are used to identify the relative influence of more than one input, dummy variables are frequently introduced to differentiate between the adopters and nonadopters.

Technological change, as experienced in the wake of green revolution, indicate changes in the use of seeds, from traditional to high yielding varieties, shifts to chemical fertiliser from farm yard manures, use of water with better management. With these changes there have been marked change in the output per unit area. At the same time there is a spread of mechanised inputs along with the seed-fertiliser-water innovation. Mechanisation has especially spread in the forms of tractor, power pumps, harvestors, threshers etc. These inputs help the timely completion of certain operations, also displace some labour in their respective operations in a given crop. Whether mechanisation displaces labour per unit area when considered for all crops during a year is the question to be tested. Papers under review attempt to answer the following questions in the light of above facts.

(i) What is the impact of seed-fertiliser-water innovation on labour input per unit area (Bisalia 1978, Dixit and Singh 1970, Acharya 1974)?

(ii) If mechanisation goes with seed-fertiliser-water innovation, is there any complementarity between the two sets of inputs? If so, what is its impact on labour use per unit area (Mehra 1976, Hanumantha Rao 1975, Acharya 1974)? The first two studies relate this complementarity question with the size of land holding also.

Some studies, in this group, examine also the impact of mechanisation, especially of tractorisation, on the labour input per unit area (Kahlon 1976, Acharya 1974, Hanumantha Rao 1975, Grewal and Kahlon 1972, Johl 1973, Chopra 1974).

The above studies have dealt with the aggregate labour input. Aggregate labour input comprises of labour flow from the cultivator's family labour and the hired labour, the latter in the forms of casual and permanent labour. With technological change there appears a change in the degree

of utilisation of various categories of labour. That is, in the production process there is a change in the importance of certain types of labour, indicating perhaps a direction to a new social formation (Kahlon 1976, Acharya 1974, Singh et.al. 1972, Garg et.al. 1972, Nanjamma Chinnappa 1977, Chopra 1974).

Labour Absorption in Agriculture

Comparing the cross country data Ishikawa (1967) found that labour input [2] per hectare in Indian agriculture is as low as 50 mandays whereas in Japan it is 500 mandays. Output per hectare is positively associated with labour input per hectare. The association is explained by the extent of cropping intensity which has impact on both labour intensity and yield per unit area. Low (high) labour input is associated with low (high) cropping intensity. The latter is again facilitated by the extension and improved management of irrigation water. Inputs other than water had a marginal impact on yield and labour use.

Vaidyanathan and Jose (1978) raised doubts as to whether this large variation in labour input per hectare can be explained by the differences in the use of irrigation water alone. They argue that the differences in agroclimatic conditions (rainfall, soil conditions etc.) have immense influence on the level of labour utilisation and yield per hectare. The role of irrigation is considered to be supplementary to rainfall. The gap between the seasonal requirements of water, given by the plant's evapotranspiration rate, and the seasonal distribution of rainfall is to be met by irrigation water. The gap between the water requirement and availability will be affected by the capacity of the soil to retain the moisture and the atmospheric temperature. However, more even seasonal distribution of rainfall as is observed in East Asian Countries, reduced the gap between water requirement and availability

which produces a soil texture favourable to higher yield and labour utilisation per unit area without much use of mechanical and animal power. To the contrary, uneven distribution of rainfall over the seasons, in South and South East Asian countries, widens the water gap that renders harder soil texture. This might result in lesser utilisation of human labour and more of alternative power inputs (animal or mechanical), especially in land preparation.

Associated with the favourable agroclimatic condition is the intensive use of manures and fertiliser. Available data for Japan, South Korea and Taiwan, i.e., countries with even distribution of rainfall, show that the level of fertiliser use is much higher, in these countries, than in the countries with uneven rainfall. The latter two countries use high dose of farm yard manures also. The higher intensity of manures and fertiliser application leads to higher intensity of labour use also, with obvious implication for yield.

The nonavailability of animal power at a large scale is another reason why more labour is utilised in preparatory tillage in the East Asian countries. In the case of India or South Asian uneven rainfall regions use of animal power in preparatory tillage becomes inevitable which substitutes labour. The use of animal power is intensified also by the easy availability reflected in its low price.

Thus, it is concluded that the favourable agroclimatic condition leads to profitable utilisation of manures and fertiliser which uses more labour. The use of labour is further intensified by the nonavailability of animal power and the redundancy of it when soil condition permits, in preparatory tillage. In the case of uneven rainfall regions, massive storage-based irrigation creates management difficulties in distributing water across the seasons. As a result cropping intensity and input intensity tend to be low leading to low labour utilisation and low yield. Use of

animal power stands as a substitute to labour use in preparatory tillage, as opposed to common belief of complementarity between the two.

The above explanations of labour use mainly based on agroclimatic condition are tentative. The conclusions are not substantiated by adequate data. This only helps formulate hypothesis that : (i) Favourable agroclimatic conditions help in the profitable use of biological-chemical inputs leading to higher yield and labour use per unit area; (ii) Animal power in the unfavourable agroclimatic conditions are substitutes for labour.

Based on the above hypotheses Vaidyanathan (1978) offers a framework for labour use analysis. He suggests a causal link. Physical inputs and biological-chemical inputs determine the level of yield per unit area. The achieved yield level requires a certain amount of energy which can be extracted from human labour, bullock and mechanical power. Amount of labour utilised will be determined by the extent of energy used from the other two sources. The composition of the energy sources will, however, depend on the relative cost of labour to other energy sources.

Physical inputs include soil conditions and moisture availability[3/] and they stand for agroclimatic condition already referred to. Biological-chemical inputs include the genetic potential of seeds, manures, fertiliser, pesticides etc. Energy inputs are human labour, bullock and mechanical power.

The analysis of labour use is based on technical and economic factors alone, and it is carried out in two steps. First, the observed differences in yield per hectare are explained by the physical and biological-chemical inputs. In the second step the observed differences in human labour input is treated as a function of yield per hectare

(representing the influence of physical-biological-chemical inputs), bullock labour days per hectare, horsepower per hectare (an index of mechanical input use) and the cost of human labour relative to bullock power. Importance of these factors is judged by the statistical significance of their marginal contribution to labour use and by the total explanatory power of all these variables taken together.

Data sources for statistical analysis are the Farm Management Studies (FMS) for various districts in India. FMS give relevant informations according to various size groups of land holding.

In order to capture the impact of agroclimatic factors and associated fertiliser use on yield an interdistrict analysis has been attempted. For this, average figures, averaging across the size groups in each district, have been compared. The association among output per hectare, irrigation index and the fertiliser use has been tried in an intradistrict analysis, using the size groupwise informations within a district.

For labour use analysis same interdistrict analysis has been attempted, using the district averages for the variables specified earlier. In the intradistrict analysis, the association among human labour days, bullock labour days, their relative costs and output per hectare have been attempted.

For interdistrict comparison regression analysis and for intradistrict association among the variables correlation analysis have been attempted.

Analysis of variance technique has also been applied to explain the sources of variation of total labour use for a given crop. The sources are regions, showing influence of agroclimatic factors, and the operations,

showing the nature of work to be done. It explains what affects the total labour use.

Finally, an attempt has been made to explain the inter-temporal changes in human and bullock labour days per hectare across operations, for three crops. No statistical relation is tried in this case.

Results of the analyses are presented without details.

The interdistrict yield analysis shows that the contribution of percentage irrigated area and the quality of irrigation, represented by the percentage area under wells and tubewells, have significant influence on the yield per unit area. The explanatory power of the equation is poor.

In the intradistrict yield analysis, involving 14 districts, the association among yield per hectare (Y), percentage irrigated area (I) and manures and fertiliser (F) has been attempted. In the Table 1, the number of districts, out of 14, showing significant/nonsignificant correlation are presented.

Table 1

Correlation between	No. of Districts appearing			
	Significant		Nonsignificant	
	Positive	Negative	Positive	Negative
Y and I	2	-	6	6
Y and F	5	-	9	-
F and I	3	1	6	4

Judging by the number of cases appearing significant, the association between yield and irrigation is poor, whereas between yield and fertiliser use the association is far stronger. The fertiliser-irrigation relation is also not too strong.

The overall human labour input per hectare, in the interdistrict regression analysis, is positively related with yield per hectare and negatively with horsepower per hectare. In both cases the coefficients are significant. All other marginal coefficients are nonsignificant.

The intradistrict association of human labour days per hectare (HLD) with yield per hectare (Y); bullock labour days per hectare (BLD) and the cost of HLD relative to BLD is presented in Table 2 (Number of districts, out of 14, showing significant/nonsignificant correlation).

Table 2

Correlation between HLD and	No. of districts appearing			
	Significant		Nonsignificant	
	Positive	Negative	Positive	Negative
Y	5	1	6	2
BLD	9	1	4	-
Cost of HLD / Cost of BLD	1	3	3	7

By the number of significant cases, the Table suggests that HLD is positively influenced by yield. HLD and BLD are in complementary relation, if not at least there is no substitutive relation (second row); and HLD and relative

cost variable are inversely related. Of the three relations, the relative cost factors appear to be weak, as 10 out of 14 cases are nonsignificant.

In the analysis of paddy crop alone the same result is borne out. HLD is positively and significantly related with yield per hectare when compared across different varieties paddy grown in different districts in India. Data for the same varieties and districts show the complementarity relation between HLD and BLD. Both observations are based on the number of cases the appropriate correlation appearing significant, in total number of cases.

In the analysis of variance, the variation in total labour input per hectare of paddy crop is due to region effect. Variation in labour use between the operations is not significant.

The intertemporal analysis of operationwise labour input for 'Desi' wheat, American cotton and 'Desi' cotton reveals that in most of the operations the use of human and bullock labour has declined between mid-fifties and early-seventies, in Ferozepur. The decline in the case of bullock is faster than in human labour. It is suspected that mechanisation in preparatory tillege, in irrigation and harvesting has caused the fast decline.

The discussion above suggests that the importance of the agroclimatic factor, particularly the water availability through out the year, in explaining yield and labour use per hectare is somewhat established, but the substitutive relation between human and bullock labour is not quite established. The paper fails to explain the positive association between human and bullock labour on the one hand, and the negative association between the human labour and the cost of human labour relative to bullock labour, on the other.

While the above studies attempted to determine the relationship between potential labour use per hectare and other inputs, studies approaching directly to this problem are scanty. Naidu (1977) attempted to correlate the number of agricultural workers with number of machines and number of working animal per 100 acres of net sown area. The correlation coefficient between the machines and working animal per unit area appeared to be negative and significant, whereas the correlation between machines and number of agricultural workers per unit area appears to be negative but not significant. Thus given the overall energy requirement, for a given level of output, mechanised inputs, especially tractor use is likely to stand in significant inverse relation with animal power whereas the position of the agricultural workers relative to tractor inputs is likely to be unaffected.

Ishikawa (1978) has provided an analysis of technological factors affecting the potential utilisation of labour per unit area as well as the factors affecting actual labour use. In a micro economic frame of individual household welfare maximisation, technological alternatives offer alternative marginal productivities and the choice therein will determine the level of output and labour input per unit area. In an attempt to explore labour absorptive capacity of agriculture without reducing the marginal productivity of labour, the author seeks the technological experience of countries where labour has been fully utilised in the process of gaining yield per unit area. Technology that corresponds to high labour input per unit area will indicate the potential for labour absorption in the cases where labour utilisation per unit area is low. Achievement of this potential may be constrained by various institutional factors and imperfect market forces faced by the farm households. Ishikawa's approach of labour absorption analysis considers the interplay of these factors.

The study of technological alternative has been guided by the experience of the process of increasing yield and

labour input per hectare in South-East and East Asian countries.

From the historical experience, cited in various case studies, of South, South-East and East Asian countries the association between yield and labour input per unit area of rice crop has been explained.

An intertemporal comparison of a district in Japan between 1850s and 1940s suggest the factors that led to the decline in labour input without affecting the yield. Lift irrigation, farm produced fertiliser mainly from mud, use of traditional implements etc., around 1850's kept the labour use at a very high level. Around 1940's, mechanical pump, commercial fertiliser, improved implements like revolving weeder, pedal threshers etc., contributed to the decline in labour input, though the commercial fertiliser created some additional labour use in weeding. Between 1956 and 1971, for Japan as a whole, intensive use of machinery in almost all operations of rice crop led to a sharp decline in labour input.

In Taiwan the spread of irrigation, fertiliser and high yielding varieties seeds contributed to the increase in labour input per unit area along with yield per unit area. However, the output per hectare and labour input per hectare are lower than in Japan during the 1970's.

Comparing West Bengal with Japan it is found that labour input per hectare in the former tended to be less than in the latter both in aggregate as well as in all the operations, especially in irrigation, manuring, interculture and weeding. Output per hectare is also lower in the case of West Bengal.

Comparing the yield and labour input per hectare between traditional and high yielding varieties (HYV) of rice in North Arcot district of Tamil Nadu (1970-71), it is observed that the shift to HYV seed required larger

labour input. The additional labour input, above the traditional varieties' labour requirement, is required due to weeding and plant protection, harvesting and later operations.

It is concluded from the above scattered studies that low output and labour use per hectare is due to low production techniques and facilities especially in irrigation and farm implements. The case of high output and declining labour input per hectare, as in Japan, arises with extensive mechanisation. The suggestive factors for increasing labour input per unit area are extension of irrigation, use of HYV, application of larger amount of fertiliser, improved cultivation practices etc.

The analysis has been extended to the total agricultural production to capture the impact of cropping intensity and cropping pattern on labour input per unit area, in the rice based areas. Rise in cropping intensity adds to the use of labour input per unit area. An operationwise distribution of labour requirement under multiple cropping condition shows overlapping of operations at some peak seasons which necessitates the introduction of selective mechanisation in some operations to facilitate productive labour use. In this connection the hypothesis that mechanisation is labour using has been tested and is accepted. Factors that are basic for additional cropping intensity are natural conditions, topography, available plant varieties, irrigation and drainage and agricultural mechanisation. The cropwise comparison, of labour input per unit area and the technological conditions required to raise the crop, identifies cropping pattern as an important factor that relates high labour input with yield per unit area.

While the technological combinations derived from the cross country experience suggest the shift in marginal product function of labour, the adoption of technological alternatives is conditioned by institutional arrangements

in agricultural sector. Also, the actual labour use is not necessarily related to technology alone. The asset holding of farm households, especially the landsize, their control over factor and product markets, alternative employment opportunities outside agriculture etc., considerably affect the labour use decision.

Ishikawa's study is appreciable in its efforts and awareness of limitations of technological factors in labour input determination. The study of actual labour use decision is extremely tentative while dealing with the wide variety of institutional systems. The main problem of cross country comparison of labour input is the varying concepts and measuring units of various data sources. It is doubted if there is a comparison of data between direct labour input in agricultural production in one country and direct and indirect labour input associated with agricultural production in another. Again the efficiency of labour input in various countries differs. Comparison, therefore, requires a correction in various fronts.

Bardhan (1978) attempts to identify the demand and supply factors and their relative roles in actual labour input determination for West Godavari (1958-59), Tanjore (1967-68), Hoogly (1956-57 and 1970-71), using the farm level data collected in the course of the Farm Management Studies (FMS) and National Sample Survey data for 1972-73.

In the theoretical formulation he treats wage rate as a function of labour productivity and the bargaining power of labour household, and a labour productivity function determined by the technological and institutional factors, labour intensity per unit area and the size of holding. From the theoretical formulations labour intensity is derived as a function of technological and institutional factors, net sown area, wage rate and the bargaining power. Theoretical conditions suggest that labour

input per unit of net sown area is negatively (positively) related to institutional factor that create disincentive (incentive) among farmers. It is positively related to land augmenting technological change, non-positively to farm size, negatively to the market wage rate and positively to the bargaining power. These conditions are applied to econometric tests for total mandays per acre per year and hired mandays per acre per year. These two variables are regressed on the variables relating to technology, institution, wage rate, size of holding etc.

Results of Godavari, Tanjore and Hoogly are presented in the Table below.

Table 3

Regressands	Regressors appearing significant with the sign of the coefficients in the paranthesis.
	GODAVARI (1958-59)
Total Mandays per acre per year (TM) Mean=102 days	(+) Multiple cropping index, (+) Percentage area irrigated, (+) number of fragments per acre, (-) Village wage rate
Hired Mandays per acre per year (HM) Mean=61 days	(+) Net sown area (+) Multiple cropping index (+) Percentage area irrigated (-) Village wage rate
HM ÷ TM Mean=0.62	(+) Net sown area (+) Percentage area irrigated (-) Village wage rate (-) No. of adult family workers per acre.
	TANJORE (1967-68)
TM Mean=83 days	(-) Net sown area (+) Value of fertilisers per acre (+) Multiple cropping index (-) Village wage rate

HM Mean = 57	(+) Multiple cropping index (-) Village wage rate (-) Adult family workers per acre	
HM ÷ TM Mean = 0.68	(+) Net sown area (+) Multiple cropping index (-) Village wage rate (-) Adult family workers per acre.	(+) Percentage area under improved paddy.

HOOGLY

	1956-57	1970-71	
TM	Mean = 53 days (+) No. of fragments per acre (+) Value of fertiliser per acre	Mean = 135 days (-) Net sown area (+) Multiple cropping index (+) Value of fertiliser per acre (+) Proportion of area not under paddy (+) Adult family worker per acre.	(-) Percentage area under improved variety
HM	Mean = 21 days (+) Net sown area (-) Adult family workers per acre (+) Value of fertilisers per acre (-) Hired bullock labour days per acre	Mean = 54 days (+) Net sown area (-) Village wage rate (-) Adult family workers per acre (-) Value of fertiliser per acre	(+) Hired bullock labour days per acre
HM ÷ TM	Mean = 0.41 (+) Net sown area (-) Adult family workers per acre (+) Hired proportion of total bullock labour days used.	Mean = 0.48 (+) Net sown area (-) Distance from the nearest railway station (+) Hired labour days for preparatory village (+) Labour days in services etc. per adult in family	(-) Proportion of cropped area not under paddy

Table 3 indicates, according to the signs of the regressors, that the total labour input tends to be positively influenced by the technological factors like percentage area irrigated and use of fertliser, institutional factor like number of fragments per acre and negatively by economic factors like the size of holding, village wage rate etc. It is also positively influenced by the availability of adult family workers per acre. The hired labour component is positively influenced by the technological factors and the size of holding, negatively by the village wage rate and the availability of adult family workers. All these factors, however, do not appear together in every district, rather they appear in different combination in different districts. The intertemporal comparison of data in Hoogly shows that there has been a substantial increase in the average number of human labour days used per acre between 1956-57 and 1970-71. The positive association between bullock and human labour in both the years has been explained by the institutional practice that the supplier of bullock often insists on supplying the labour also.

Out of several factors in Bardhan's analysis we consider that technological and economic factors and the availability of family labour have turned out important in explaining the labour utilisation behaviour across farms. The treatment of institutional factor in terms of number of fragments per acre is unsatisfactory. The inclusion of more important aspects, like production relation, forms of tenancy and the input uses therein, might lead to a satisfactory explanation of inter-farm differences in labour use.

Bharadwaj (1974) provides a more improved framework of labour use analysis. She compares labour input per acre, provided by FMS, across size classes and regions. On the demand side, cropping intensity and cropping pattern have considerable influence on labour input, on the supply side, which is the main focus of analysis, the differences

in labour use per acre are attempted to be explained by unequal access to input and product markets for various size groups, unequal bargaining power of agricultural workers, work-leisure preference, alternative non-agricultural employment opportunities etc.

Technology and labour use

Impact of technical change on labour input per unit area is varied. Land augmenting factors like seed-fertiliser-water combination often have positive impact on labour demand, whereas the impact of mechanisation is yet to be clearly identified. Relative impacts of two sets of technological change on labour demand are presented below.

Impacts of land augmenting inputs

Bisaliah (1978) examines whether the land augmenting technology has any favourable impact on the labour use per unit area. The change is accounted for by the difference between adopter and nonadopter farms in labour and other input use. The change in the labour use per unit area is decomposed into, (i) new technology (HYV) effect, (ii) wage rate effect and (iii) complementary input (irrigation, fertiliser etc.) effect. Farm level cross section data of Punjab (1967-68) for local and Mexican wheat have been applied to the decomposition analysis. Results suggest that 12 per cent of the increased employment per acre for adopters over the nonadopters is explained by the change in technology i.e., by the adoption of HYV against traditional variety of seeds. 15 per cent of the negative employment effect is explained by wage variations among farms of two different technologies. Complementary inputs explain 54 per cent of the total increase in labour input per unit area, of the 54 per cent, irrigation contributes 9 per cent, capital 5 per cent and fertiliser application 40 per cent. Factors explaining the rest of 19 per cent variation are ignored because they do not come under the HYV and associated inputs.

The study is incomplete in the sense that if some types of mechanisation do act as land augmenting inputs, like pump set, the positive association between this and HYV and impact thereof on labour use need to be studied together, though their relative impact is to be known separately. The study does not provide any yield analysis and is confined to single crop production.

Dixit and Singh (1970) also measure the impact of high yielding varieties seed on yield and labour input per unit area. Additionally, the study attempts to explore the size effect on yield and labour use. It uses the method of comparison of inputs and output between HYV and traditional varieties seeds. The chosen village in U.P. has 85 per cent area irrigated. Only 12 farms' data are divided into 3 size groups. Result suggests that the yield per unit area is higher for HYV seeds than for traditional varieties. Human labour days per unit area is higher for HYV than for traditional variety, though in each case it declines with the increase in size. Similar is the effect on bullock labour days. Total as well as hired labour are higher in HYV than in traditional varieties area, and the proportion of hired labour increases with size. In an operationwise analysis it is observed that in every operation labour input per unit area is higher for HYV areas than for local varieties'.

Both the studies do not control the variables, like mechanised inputs, which might affect the yield and labour use for overall agricultural production. In cross section studies as these impacts of such variables would be implied to be same for both adopters and nonadopters or there is a likelihood of association between HYV and mechanisation (as will be evident later) in the adopter farms. Hence the inference is likely to be unreliable.

Mehra (1976) makes a more cautious effort to identify the impact of irrigation, seed-fertiliser-mechanisation

(i.e., of technology), cropping pattern and farm size on overall labour input per unit area. Ensuring the positive association between yield and labour use over time, she proceeds to explain the impact of the above factors on the increase in labour utilisation observed over time. She applies both cross-sectional and intertemporal comparison on the data of Ferozepur, Punjab. Data are used from the FMS (1956-57 and 1966-70).

It is postulated that irrigation facilitates increased cropping intensity, shifts in crop pattern and productive labour use. Choosing only wheat crop in irrigated and unirrigated areas, the effect of crop pattern is controlled. Separating the extra cropping intensity, that is not due to irrigation, by unitary method-relating the observed rates of increase in irrigation and cropping intensity, the impact of irrigation on additional labour input per unit area is estimated. This factor explains the 46 per cent of the total gain in labour input per unit area between 1956-57 and 1966-70.

Impact of seed-fertiliser and mechanised inputs on labour use is studied by comparing for the same crop over time and by comparing the traditional and high yielding varieties at a point of time. The following table is suggestive:

Table 4

Mandays per acre, Ferozepur

1956-57	1967-70	
Desi wheat	Desi wheat	Mexican wheat
68.9	52.3	68.2

(Table-4)

Comparing mandays per acre/of 'Desi wheat' between 1956-57 and 1966-70, it is clear that extensive mechanisation has displaced labour. Comparing between Desi and Mexican wheat, in the period 1967-70 the effect of HYV-fertiliser on labour use is captured. These inputs appear to be labour absorbing. Finally the camparison between Desi wheat in 1956-57 and Mexican wheat in 1966-70 indicates no change in labour input per unit area, suggesting that the seed-fertiliser technology impact has been neutralised by mechanisation. In view of neutralisation of effects it could be asked if there is any complementarity between land augmenting inputs and mechanisation.

Thus technology impact being nil the rest of the change in labour input per unit area is assumed to be explained by cropping pattern.

Mehra's analysis relates to the average figures for all farm size groups. The analysis of size effect is deferred to the next issue of tractorisation. However, while Mehra meticulously separates the impact of irrigation on additional labour input per unit area, the technology question is not properly answered. Fall in labour input need not necessarily be the result of mechanisation. It is quite possible that gain in yield from HYV can offset the yield loss in traditional variety. Hence farmers might profitably reduce the labour input in certain operations of traditional variety and increase that in the case of HYV even without mechanisation. To conclude either way there is a need for (a) relating the labour input change with yield variation and (b) operationwise breakdown of labour to ascertain the factors.

Acharya (1973), among several things examines the impact of bio-chemical factors, i.e., of seed-fertiliser combination, on labour input per unit area. He uses farm level data, from Rajasthan villages, of participants and

non-participants of green revolution. Classifying the two categories of farms into mechanised and non-mechanised, and the former again into tractorised and nontractorised and pump using and non-pump using, the cross sectional change in labour input per unit area is attributed to the differences in the specific input uses. Difference in the labour input per unit area between participant and non-participant farms will indicate the change due to bio-chemical inputs.

The study has shown the difference between the participant and nonparticipant farms' cost structure, yield and cropping intensity. All these components are higher for the participant farms. We shall defer the analysis of mechanisation till the appropriate place of discussion. Table 5 reveals the differences in labour use due to relevant factors:

Table 5

Total Human Labour-days per unit of Net Sown Area

	Non-participants	Participants	% change in labour days used: Participants over non-participants
1. Nonmechanised	73.2 (60.8)	113.4 (82.9)	55.0 (36.3)
2. Pump	60.0 (48.5)	90.3 (66.1)	50.5 (36.3)
3. Tractor	--	82.4 (52.4)	--
% decrease over non-mechanised in			
4. Pump operated farms	-18.0 -(20.0)	-20.3 -(20.2)	
5. Tractor operated farms	--	-27.3 -(36.8)	

Reading across the first row, the third column indicated that the bio-chemical inputs contribute to higher labour use per unit of net sown area by as much as 55 per cent. Since that may include the effect of cropping intensity effect between the two categories of farms, figures in the parantheses, labour days per unit of cropped area, need to be compared. This removes the cropping intensity effect. After removal of this effect new technology without mechanisation contributes to 36.3 per cent addition in labour use per unit of cropped area (first row, third column).

The drawback of the study is that it does not inform about the differences in the level of irrigation, if any. Irrigation also has a unique effect on the labour use. Also, the lack of operationwise information hides the relative impact of various land augmenting inputs.

Impact of Mechanisation

Studies in mechanisation and its relationship with labour input and output per unit area mainly focus on the complementarity between land augmenting inputs and mechanisation along with size effects, and the impact of tractorisation on cropping intensity, yield and labour use per unit area.

On the problem of complementarity C.H. Hanumantha Rao (1975) assumes that as the size of holding increases, application of land augmenting inputs become profitable only if it is followed by mechanisation. Assuming that pump set, HYV and fertiliser are in complementary relation with tractor inputs, the levels of output employment and cropping intensity have been compared between tractor and bullock farms. Farm level data collected in the course of FMS, have been classified into tractor and bullock farms, according to their ownership. Controlling for the size effect and the level of irrigation between the two sets of farms, the impact of complementary inputs and tractorisation

is analysed. A loglinear regression equation, with an intercept dummy for the tractor farms, indicate that the cropping intensity, output and employment (man hours per year) are all higher in tractor than in bullock farms.

Mehra (1976) following the same argument of complementarity argues that the labour input per unit area increases due to land augmenting inputs, but gets nuetralised due to mechanised input use. She does not control for size and irrigation to obtain the real impact. Rather she attempts to capture the size as an important variable explaining complementarity. She observes from FMS data of Ferozepur, 1966-70 that labour input per unit area and the cropping intensity decreases with size. Controlling for cropping pattern variation across size classes, the decline in labour input per unit area is attributed to mechanisation.

Both studies use FMS' data. Farm classification according to ownership of tractors does not signify tractor use, and impact therein is misleading. Problem with Mehra's study is that it uses the average labour days for each size group. This implies that all farms are equally tractorised which is not true. The conclusion therefore is biased. The importance of complementarity between land augmenting and mechanised inputs is difficult to be established. It is therefore worthwhile to control all other factors while studying the impact of mechanisation.

The studies in tractorisation focus on total labour input per unit area, cropping intensity, yield and bullock labour employment. Whether tractorisation affects these variables positively or negatively is the purpose of all the studies. Since many other inputs may affect the variables in the same way, methodological considerations suggest that other inputs be properly controlled.

In the earlier reference Hanumantha Rao (1975) argues that the output, cropping intensity and employment differences

between the tractor and nontractor farms may occur due to various other factors. Hence to ascertain their relative roles, he uses a linear regression model with intercept and slope dummies for the tractor farms. Since in neither of the cases tractor dummies appeared significant, he concludes that labour displacement effect of tractorization is well compensated by the rise in cropping intensity.

The data problem apart, it needs to be shown whether tractor farms necessarily achieve higher cropping intensity than the nontractor farms.

Johl (1973) contends that the hypothesis of labour displacement due to mechanisation is based on certain erroneous notions. Favouring mechanisation he offers the following reasons. 1. For a given level of output mechanisation leads to the substitution of labour. But mechanisation helps, (i) intensive use of labour in operations where machines are not used, (ii) and allows repetition of process (i) which creates additional demand for labour. 2. Sometimes, lack of mechanical power restricts both extensive and intensive cultivation of land leading to lower demand for labour. 3. The labour displacement hypothesis often ends up in comparing the uncomparables. Labour employed with traditional implements is not comparable with labour employed with mechanical power. The latter combination may be used for dry land cultivation, whereas the former cannot be. In this sense the two are incomparable, and they form the two different sources of energy.

Mechanisation relaxes the constraints (1) - (3) and makes intensive and extensive cultivation possible. Therefore mechanisation has a positive effect on labour demand. This hypothesis is tested with the help of time series data for the Punjab state since 1966-67 to 1969-70. The data suggest that due to tractorisation both cultivated and cropped areas have increased. While on the aggregate, over this

period, 44 per cent rise in tractor power has reduced bullock labour days by 28 per cent, it has increased manhours required for total production by 58 per cent. The phenomenon is associated with green revolution. It is argued that green revolution involving new seed-fertiliser-water combination needed better management of farms. Also extensive and intensive cultivation became profitable after green revolution. Bullock power was incapable of supplying the huge energy requirement in time, especially for harvesting one and sowing another crop, with land preparation in between. Also, the use of HYV seeds, chemical fertiliser and water created a demand for labour, which perhaps exceeded the locally available labour.

Johl's arguments are not based on the separated effects of seed-fertiliser-water inputs and mechanical inputs. As a result the machine effect on labour use could not be exactly identified.

On a similar line Grewal and Kahlon (1972) argue that mechanisation, especially tractorisation, does not displace labour. Controlling for the region, cropping pattern and size effects, they compared the cross-section data of labour use in predominantly bullock and predominantly tractor farms in Punjab state, 1969-70. An operationwise comparison between the bullock and tractor farms indicates that the tractorised farms displace labour in preparatory tillage (by 88%), sowing (by 17%), threshing (by 12%) and transportation (by 43%) and additionally intensify labour use in fertilising, harvesting, weeding and irrigation. The additional intensity compensates for the displacement in human labour. There is no evidence of substantial net increase in the labour use due to tractorisation which could support the broad arguments earlier provided by Johl.

Singh <u>et. al</u> (1972) have studied the impact of mechanisation and other inputs on labour use in various operations for three sets of farms in Kanpur, U.P. 67 sample

farms are classified into traditional, progressive and highly progressive groups. Traditional farms have no improved implements and have less than 25 per cent of area under HYV. Progressive farms own tube well and cultivate 25 per cent to less than 50 per cent of area under HYV. Highly progressive farms have tractor, tube well and 50 per cent or more area under HYV. Operation-wise breakdown suggests that while the progressive farms absorb larger quantity of labour days in all operations except threshing over the traditional farms, highly progressive farms utilise higher labour days, in manuring, irrigation, interculture, harvesting and threshing, as compared to the progressive farms. In threshing operation traditional farms use less labour than the highly progressive farms do. In between them stands the labour use of the progressive farms for the same operation. In the ploughing operation the highly progressive farms use the least amount of labour among the three sets of farms.

Among the three sets of farms only the highly progressive farms use tractors. The impact of tractorisation is felt only in the ploughing operations. It is not clear whether tractorisation has displaced labour in other operations which may have been compensated by the HYV effect. The effect of tractorisation cannot be separated from HYV effect because the latter is not controlled properly.

Kahlon (1976) attempts a finer analysis of control of various factors affecting labour demand, cropping intensity and output.

At the sampling stage cropping pattern is controlled by choosing homogeneous zones with respect to crops. Tractor population is divided into several horse power groups. Size effect is controlled by covariance analysis. Stratified sample of farms are divided into bullock operated

farms and tractor operated farms. For the uncontrolled variables, the author has found insignificant correlation coefficient between size and cropping intensity. Between the two broad sets of farms there is no significant difference in yield and fertiliser use, level of irrigation and yield. Only difference noticeable between the two sets of farms is in the cropping intensity.

With controlled data linear and loglinear production functions are fitted with intercept and slope dummies for tractorised farms. In the linear case, the coefficients of human labour input remained unchanged between tractor and bullock operated farms because the dummy influence is insignificant. Only for bullock labour dummy influence appeared negative and significant. Thus tractorisation does not displace human labour, but displaces bullock labour. The result of loglinear function does not show any significance of dummy on human and bullock labour coefficients which suggests that tractorisation does not influence the human and bullock labour input negatively.

In a similar way Hanumantha Rao (1975), while studying the complementarity among technical inputs, concedes that the results of comparison between tractor and non-tractor farms may be obtained due to the interplay of various factors. Hence, it would be worthwhile to study the relative impact of each of the technical inputs. Output, cropping intensity, yield per unit area and employment (annual total man-hours) are regressed on the technological inputs. Tractor dummy on intercept and slope, in the regression equations, indicates the differences in the coefficients in the two types of farms, and hence the differences in the relative impact.

As the tractor dummy for all the regressands turned out to be insignificant, Rao concludes that immediate labour displacement effect of tractorisation is compensated by the labour demand due to the rise in yield and

cropping intensity. The last two variables are found to be significantly associated with irrigation, HYV and quality of irrigation such as the utilisation of tube-well.

Despite the problem of interpreting the FMS data, the methodological problem arises as to whether additional cropping intensity and the application of HYV are very special practices in tractorised farms.

Acharya (1973) arrives at an opposite conclusion. Recalling the method of comparison between participant and non-participant groups and between the mechanised and non-mechanised farms within each groups, he concludes that among non-participants, pump operated farms use 20 per cent less of human labour days per unit area than the nonmechanised farms (Table 5, row 4). Table 5, rows 4 and 5, indicate that pump use among participants reduces labour input by 20 per cent and tractor use reduces it by 36.8 per cent over nonmechanised farms.

Though Acharya's analysis helps identify the relative influence of HYV and mechanisation on labour input, his method does not separate the effect of tractorisation from pump use on labour input. Among his farms tractor using farms may use pump sets also, in which how much labour displacement is due to pump or tractor is unidentified. In this analysis the effect of cropping pattern is missing.

Chopra (1974) captured the impact of tractorisation on labour use by comparing the farm situations before and after tractorisations. The sample farms are selected from 13 villages, in three blocks of a district in Punjab. 130 tractor owning households were chosen from these three blocks, characterised by varying irrigational systems. Since over time the level of irrigation among these farms increased, to remove the effect of this factor 52 farms were chosen, for which the total cultivated area and the area under irrigation did not differ substantially.

The results of comparison between the situations <u>before</u> and <u>after</u> suggest that these 52 tractorised farms, where irrigation is controlled had 13 per cent additional cropping intensity due to tractorisation. While this will have favourable impact on the labour per unit area, the HYV and tractorisation together have produced **a very high employment** level. But the impact of tractorisation is analysed only in expansion of cultivated area.

The study fails to remove the confounding effects of various other factors like, pump sets, representing the management of irrigation water, and the introduction of HYV seeds in the wheat cultivation. Also, the data collected represent tractor ownership rather than actual use which has the same drawback as the FMS data, cited earlier.

Binswanger (1978) attempts to infer the impact of tractorisation on the basis of maximum number of available studies showing a particular result. He distributes the studies at various levels of additional cropping intensities and additional labour use per unit area. As for cropping intensity, few studies indicate a decline in cropping intensity over 10 per cent and few indicate rise above 10 per cent. Rest of the studies, rather a bulk of them indicates the change in cropping intensity between —10 per cent and +10 per cent, implying that impact of tractorisation on cropping intensity in inconclusive. In the similar way the impact on labour input per acre is studied, and concluded that tractorisation has, often, no favourable impact on labour use, sometimes, it has marginal negative effect. This particular study should not be treated as a study on mechanisation as such, but the methodological disection of every study that is evaluated is particularly interesting and revealing.

Studies in technological change, though indicate certain definite features, whether it is labour absorbing or displacing or yield raising, somehow appear apologetic either

in favour of or against adoption. More important feature often eluded is that agriculture is undergoing a structural change. Mechanisation, particularly tractorisation, is an indication that process of production is becoming less dependent on current labour and more on alternative sources of energy including congealed labour in the machines. Protagonists argue in favour of the substitution purely on technical and economic basis, the latter is quite innocently vitiated by the frame of competitive market mechanism. The basis need not be purely economic to cause widespread substitution of machines for labour in the process of production. When transformation starts in many alternative spheres reasons for change should be sought in more fundamental elements like social formation associated with the changes in production process.

Demand for various labour categories

Analyses of technical change suggest that yield and labour input per unit area are positively related in the application of purely land augmenting inputs, whereas the impact of mechanisation is yet inconclusive. Mechanisation,displacing labour in particular operation, and helping intensify labour use through additional production, creates a mixed reaction about its impact, exceptions are Acharya and Mehra. However, on the whole when total labour use increases, some studies explored how this additional absorption is distributed among various categories of labour. This is important in order to assess the prospect of employment among the hired labour and/or family labour, implying the impact on agricultural labourers and cultivators. Given the supply of labour in each category, their relative levels of unemployment associated with technological change can also be assessed.

Kahlon (1976) estimates the demand for labour, as a function of size of holding, percentage area under irrigation, expenditure on yield raising technology, and the

wage rates, for each category of labour like family labour, casual labour and permanent hired labour. Purpose being the analysis of the impact of tractorisation, intercept dummy and slope dummy on size and technology have been used to identify the differences between tractor and bullock farms. Estimates of the demand functions are obtained by linear and loglinear regression methods.

Both linear and loglinear estimates of demand for family labour indicate that tractor farms use of family labour increases with size due to tractorisation. Reason often advanced is that work being easy with mechanisation farm workers of higher size groups prefer work to leisure and can manage a larger farm better now. Slope dummy being nonsignificant for permanent and casual labour, demand for these categories of labour is unaffected by tractorisation.

Chopra (1974) studies the changes in the composition of labour due to tractorisation. Comparing the before and after situations of tractor use, among the tractorised farms, she observes that there has been a slight decline in permanent hired labour days per acre, whereas family and casual labour per acre increased marginally.

Acharya (1974) comparing the participants and non-participants of overall technical change shows a rise in the proportion of hired labour and a fall in that of family labour in the total labour input per unit area. Between nonmechanised and pump operated farms, among the nonparticipants, the fall in the proportion of family labour is about 8 per cent. Among the participants of HYV, the fall in the proportion of family labour is about 9 per cent. Again between nonmechanised and tractorised participants of HYV, the proportion of family labour declined by 60 per cent. The decline in the proportion of family labour is compensated, in all cases, by the rise in the both casual and permanent hired labour.

Singh *et al* (1972) have shown, with the Kanpur data, the different composition of labour use in traditional, progressive and highly progressive farms. It is cited that family labour days decline with progressiveness of farms. Permanent hired labour is nil in the traditional farms and present in the other two categories of farms of which the highly progressive ones absorb larger mandays than the progressive farms. Hired casual labour days increase with the progressiveness of the farms. Across these groups of farms, the proportion of hired labour increases with progressiveness, and in the progressive and highly progressive farms hired casual labour forms the highest proportion family labour forms the lowest proportion with permanent hired labour days lying in between. On the whole, progressiveness is associated with the absorption of hired labour.

A similar conslusion has been reached by Garg *et. al* (1972). A time series comparison of the Kalyanpur block of Kanpur, U.P., during 1966-67 and 1970-71 indicate that over the period area under HYV maize, paddy and wheat has increased from 11 per cent to 35 per cent of the total cropped area. The adoption of HYV, as compared to traditional variety, absorbs larger mandays, and has tilted the composition of labour categories towards hired labour during 1966-67 and 1970-71. Family labour in total mandays has declined from 80 per cent to 65 per cent which implies a rise in the percentage of hired labour days in a two-category distribution of labour.

Nanjamma Chinnappa and Silva (1977) estimated the change in the proportion of family and nonfamily (hired+attached) labour use arising from a shift from the traditional variety to high yielding variety paddy in North Arcot district of Tamil Nadu during 1972-73. A shift from TV to HYV resulted in a decline from 37.6 to 35.4 persondays per acre for family labour and the increase from 6.4 to 12.00 persondays per acre for attached labour and from 62.0 to 75.7 persondays for hired labour. This shows a decline in the proportion of

family labour and rise in that of nonfamily labour due to technological shift.

An operationwise distribution of labour days shows that due to technological shift the family labour use per acre increased in ploughing and transplanting whereas it declined in all other operations. For nonfamily labour, persondays per acre increased in all operations, except for ploughing and manuring (ibid).

The reasons for chenges in the proportion of the two broad categories of labour are (i) the big farmers who are also the large scale adopters of HYVs use less of family labour and more of nonfamily labour. The additional demand created by HYV therefore is met by hired labour; (ii) small farmers having utilised the family labour fully hired in substantial quantity of labour to meet the demand in crucial labour intensive operations like, transplanting, irrigation, weeding, harvesting etc.

The two reasons, however, are not substantiated by data on size of holding.

Studies on the impact of mechanisation on the composition of labour input are scanty. One study for Punjab suggests an increase in the involvement of family labour with mechanisation (Kahlon). Acharya (1974) shows a different trend - decline in the proportion of family labour - in the case of Rajasthan. Chopra (1974) only considers land preparation and labour composition therein for tractor farms, where the proportion of family labour rises marginally. Since Chopra considers only one operation no definite conclusion regarding the total labour composition is offered. However, varying forces are in operation with respect to regions, and may be also according to the stages and process of technical change.

Summary

1. Labour input per unit area is positively associated with the yield per unit area. Primarily the application of biochemical inputs, like HYV seeds, fertiliser, conditioned by the availability of water, soil moisture etc., (the physical inputs) determines the level of yield and the total energy requirements. Technical relationship, complementarity or substitutability among the energy inputs - labour, bullock and other mechanised inputs - and their relative costs determine the use of labour vis-a-vis the other energy inputs (Vaidyanathan 1978). Cross section analysis of data, from the Farm Management Studies, claims to have established the primacy of physical-biological inputs in determining yield and labour use both for overall agricultural production and paddy crop. Labour process, thus, is considered to be a purely technical phenomenon (Vaidyanathan 1978).

2. Ishikawa (1978) analyses the technological components of labour utilisation, where the technological choice is a part of the farm's overall welfare optimisation under various internal and external market constraints. From a cross country experience of the labour absorption process under technological change Ishikawa (1978) infers that at the early stage of development, particularly in a labour abundant situation, minor irrigation, drainage, farmyard manures etc., may raise the level of output and labour use. Through the increase in cropping intensity and appropriate choice of cropping pattern. In the latter stages of labour scarcity some mechanisation along with better water supply and management, application of seeds etc., can be adopted to sustain higher yields, though there can be some displacement of labour.

3. Bardhan's (1978) analysis can be broken down into two parts. First, the yield per unit area is a function of technological and institutional factors; secondly, yield

is a function of size of holding, labour intensity per unit area, wage rate etc. First part suggests a shift in the production function and the second part is the movement along the production function, given the technology and institution. Farm level data from FMS are utilised to show that total labour input per acre is inversely related with the size of operational holdings, positively with the level of irrigation, use of fertiliser, multiple cropping index etc., only two institutional indicators used are number of fragmentations per acre, and the percentage area leased in. In most cases regression equations do not indicate high explained variation.

4. Bharadwaj (1974) distinguishes labour utilisation by size classes in a static frame. The study offers a number of hypotheses regarding the labour use. The most important one among them is that small farms utilise more labour per unit area due to higher cropping intensity and the choice of more labour intensive crops than do the large farms. Later, it is suggested that the labour process is not a function of technological process alone. Involvement of various groups of farmers and the agricultural labourers in various markets and interlinkages therein control the production and thus the labour process.

5. Naidu (1977), however, attempts to explore whether mechanisation has any impact on the use of human labour and bullock labour. It is shown that mechanisation displaces bullock labour but does not do so to the human labour.

6. In the analysis of technical change and labour absorption, the unique positive impact of land augmenting technological change has been established (Bisaliah 1978, Mehra 1976, Hanumantha Rao 1977, Dixit and Singh 1970, Acharya 1974, Kahlon 1979).

7. There has been doubts whether the adoption of land augmenting technological change can be separated

from mechanisation which has a dampening effect on the labour absorption. The complementarity of two types of technological change, it is claimed, gets accentuated as the size of operational holding increases (Mehra 1976, Hanumantha Rao 1975, Acharya 1974).

8. Number of studies on tractorisation defend the use of tractor on the ground of additional cropping intensity and yield. Tractorisation displaces labour in some operations but compensate the effect through intertemporal substitution of labour and rising cropping intensity, as is sometimes argued (Hanumantha Rao, Kahlon, Grewal and Kahlon etc.). Some suggest that tractorisation has a net displacement effect (Mehra 1976, Acharya 1974, Binswanger 1978). Studies on tractorisation use often cross section information. Debate centres around the methodology of exactly identifying the impact of tractor by controlling the confounding effects of other inputs.

9. Associated with the technological transformation is the change in the form of labour use. There is a shift in the proportion of family and hired labour due to mechanisation. The pattern is not unique. It differs over regions, crops, size of holding etc., hence general conclusions are yet to be arrived.

Further problems and scope on labour absorption

In answering what determines the yield and labour use per unit area in agriculture, the importance of physical-biological factors needs a careful investigation. But the *a priori* emphasis on the causality that the physical-biological factors determine the labour use is slightly overdrawn. Since the application of biological inputs depends basically on labour, the shortage of the latter may as well hold down the level of yield and input utilisation. Next, the calculation of the relative costs of the energy inputs poses a difficult problem in valuing the family labour especially

where it is predominant. Owing to technological and social rigidities family labour may not offer itself in the labour market as a parallel to the hired labour. Also owing to the heterogeneity between family and hired labour and the performance of the heterogeneous functions in different operations the use of marginal productivity of labour becomes difficult and calculation of appropriate opportunity cost of labour poses a problem. Hence neither the market wage rate, nor the opportunity cost of labour can be used as an index of the cost of the family labour.

Studies that obtain labour process as a purely technological phenomenon emphasise the role of irrigation as of prime importance. Use of the FMS data, which gives only the percentage net area irrigated, in this regard does not take us far. The quality of water and the availability of water for the second and third crop at the time it is required will have considerable influence on the cultivated area under the second and third crops, and thus on the labour input per unit area. Studies hitherto have ignored the quality and the management aspect of irrigation water and its influence on the cropping intensity and labour utilisation.

Another missing aspect is the influence of cropping pattern on the labour utilisation per unit area. Since it is difficult to capture this influence in a quantitative estimate, it is essential to obtain the technical limits of labour use with the least labour intensive crop pattern and the most labour intensive crop pattern feasible in a given homogeneous agro-climatic region.

In Bardhan's study another problem is the treatment of production and the size of holding. It is true that labour input per unit area varies inversely with size and the small farms with no or little opportunity of off - farm employment utilise the available land intensively. But the use of single production function across all size groups demands justification. In this method, size is identified

with technical combination of inputs. In that, size (technique) and yield as well as labour use get inversely related as a part of the given production function. It is reported that in irrigated areas there is no such particular monotonic relation (Bharadwaj, 1974). This is suggestive of the fact that all size groups do not operate along a single productio function, and their techniques are not comparable. What is needed is to identify the production process in various categories of farms and the labour process therein. Classification of farms according to the size of holding does not, however, clearly reveal the nature of farm practices. Classification of farms according as whether farming alone provides income below or above or just subsistence expenditure (Lenin 1967) and the labour process in each of them can be a meaningful study.

The treatment of institutional variable, explaining labour input per unit area, in terms of percentage area under tenancy is far too aggregative. The production processes under various tenancy conditions are likely to differ. Tenurial contract, like tenancy at will, is likely to dampen the incentive for using modern technology which will restrict the use of additional labour. On the contrary, landowner sharing a part of the input with the tenant may induce larger labour utilisation. These examples indicate that the neglect of such modes of operation may produce misleading results of labour utilisation. Technological possibility of labour absorption with different tenancy arrangement may be different. It would be interesting to explore the area in greater details.

However, the studies under review provide exercises on aggregate labour input per unit area for the total crop production in a year. While this captures the effect of cropping intensity and cropping pattern the experience is not so much useful. Between a mechanised and a nonmechanised farm aggregate labour input per unit area may turn

out to be same, but the operationwise distribution of labour input, performing heterogeneous functions, may be different. Also, for predictive purposes the experience from aggregated data of varying crop mix is not helpful. Experience of labour process, for example, in wheat and paddy production are quite different. While the former crop does not need transplanting the latter does. In that labour process in the two crops will be widely different. Hence to obtain accurate understanding of labour process and a more generalised experience, study of technical determination of labour input should concentrate on all crops separately and their heterogeneous operationwise distribution of labour.

The purpose of the reviewed studies was to spell out the techno-economic constraints of labour utilisation. Since labour is utilised in applying inputs and managing the farm production, it becomes a technical factor. But the possibility that the socio-economic constraints on various groups of farms can also affect the farm decisions and thereby technological possibility of labour use, has missed attention. The decision making process, for example, of a predominently self-employed farm differs from that of a farm using hired labour. Differential accessibility of farms to the factor and product markets may distribute crucial inputs like fertiliser, water etc., against the poor farms which will have tremendous bearing on the production decision and labour use. These examples suggest that the farms, according to varying circumstances they face become heterogeneous units with varying interests and objectives. The neglect of the decision making processes in the quantitative analysis is likely to produce a wrong insight about the labour process in agriculture.

However, if the differences in farm decision behaviour are to be accounted for, aggregate informations thrown up by the FMS, as they are used by most of the studies in 'Labour Absorption' are of little use. In fact the field

level informations or case studies on farm household's economic organisation would provide better understanding of specific issues therein.

Related with the problem of labour absorption is the question as to who benefits from the increased labour absorbability. We have seen that technological break through is associated with the absorption of higher proportion of nonfamily (hired + attached) labour. This might be a hopeful picture as it may involve the agricultural labourers and poor farmers. But whether the technological change has resulted in a better distribution of income is to be carefully examined. So far available evidences do not necessarily indicate a hopeful picture. (Bardhan 1970, Bardhan 1977).

The studies in technological change and labour use have indicated about the complementary relation between the HYV-water-fertiliser package and mechanisation, especially tractorisation. On the one hand Mehra and Hanumantha Rao argued that the complementarity between the two sets of inputs arises following the management difficulty in the large sized operational holdings. That is, in the small farms such complementarity is less likely to occur. On the other hand, it follows from the works of Ishikawa, Johl, Kahlon and others that the complementarity between the inputs occurs due to other reason. The introduction of HYV reduces crop duration and facilitates multiple cropping. Multiple cropping creates an overlapping of certain operations between the two crops where available labour cannot perform the given task. Mechanisation can alone relax the labour supply constraint during such overlapping of seasons; hence the complementarity. If this is true, the complementary relation between HYV package and mechanisation need not occur only in the large sized operational holdings. However, it is also not clearly known how greatly HYV has induced multiple cropping and overlapping of operations such that

mechanisation becomes inevitable. It appears, therefore, that the analysis of complementarity is incomplete. It should be seriously examined as to why and under what circumstances does the complementarity between HYV package and mechanisation, especially tractorisation, arise. A related inquiry would be whether the two types of inputs could be applied independently of each other. The answer to the latter question may highlight the prospects of creating larger employment opportunity with higher productivity in agriculture.

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Foot Notes

1. Technological factors include the use of water, seed, fertiliser, tools and implements etc. Economic factors are the choice of techniques, choice of crops, based on market prices of factors and products, economies or diseconomies of scale due to size of holding etc. Availability of adult farm-family workers can be classified into demographic factors, whereas caste system, production relation etc., can be classified into institutional factors.

2. Labour input is measured in man equivalent days, i.e., adult male and female labour and child labour are standardised into adult male labour days using the relevant conversion ratios.

3. Moisture availability implies the water availability from rainfall or irrigation sources.